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(74) Agents: ROMEDAHL, Bengt et al.; Kransell & Wennborg AB, Box 27834, S-SE-115 93 Stockholm (SE).

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(71) Applicant (for all designated States except US): ALLGON AB [SE/SE]; P.O.Box 500, S-184 25 Åkersberga (SE).

(72) Inventor; and

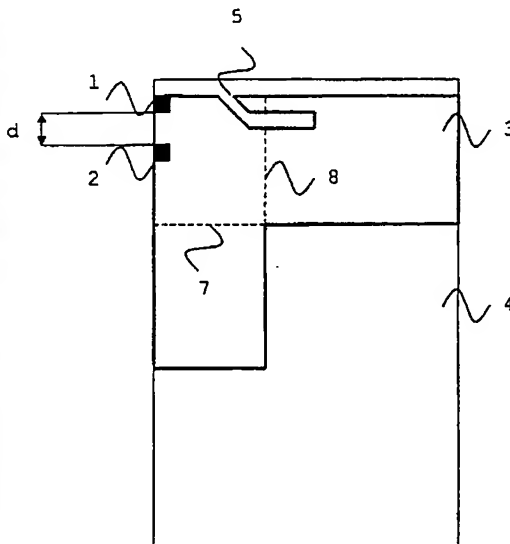
(75) **Inventor/Applicant (for US only):** YIDONG HU, Annika
[CN/SE]: Bivågen 103, S-184 38 Åkersberga (SE).

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[Continued on next page]

(54) Title: A WIDEBAND MULTIBAND INTERNAL ANTENNA DEVICE AND A PORTABLE RADIO COMMUNICATION DEVICE COMPRISING SUCH AN ANTENNA DEVICE



(57) Abstract: The invention relates to a problem with how to achieve a wideband multiband internal antenna device. This is obtained by providing an antenna device that radiates in at least two frequency bands, comprising a first and a second frequency band, comprising: an essentially planar radiating conductive element (3) comprising a first and a second portion, wherein said first portion radiates essentially in the first frequency band and the second portion radiates essentially in the second frequency band, wherein said first and second portions are generally rectangular, essentially orthogonal to each other and have a common portion, whereby a wide first frequency band is provided.

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1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280 281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 310 311 312 313 314 315 316 317 318 319 320 321 322 323 324 325 326 327 328 329 330 331 332 333 334 335 336 337 338 339 340 341 342 343 344 345 346 347 348 349 350 351 352 353 354 355 356 357 358 359 360 361 362 363 364 365 366 367 368 369 370 371 372 373 374 375 376 377 378 379 380 381 382 383 384 385 386 387 388 389 390 391 392 393 394 395 396 397 398 399 400 401 402 403 404 405 406 407 408 409 410 411 412 413 414 415 416 417 418 419 420 421 422 423 424 425 426 427 428 429 430 431 432 433 434 435 436 437 438 439 440 441 442 443 444 445 446 447 448 449 450 451 452 453 454 455 456 457 458 459 460 461 462 463 464 465 466 467 468 469 470 471 472 473 474 475 476 477 478 479 480 481 482 483 484 485 486 487 488 489 490 491 492 493 494 495 496 497 498 499 500 501 502 503 504 505 506 507 508 509 510 511 512 513 514 515 516 517 518 519 520 521 522 523 524 525 526 527 528 529 530 531 532 533 534 535 536 537 538 539 540 541 542 543 544 545 546 547 548 549 550 551 552 553 554 555 556 557 558 559 560 561 562 563 564 565 566 567 568 569 570 571 572 573 574 575 576 577 578 579 580 581 582 583 584 585 586 587 588 589 590 591 592 593 594 595 596 597 598 599 600 601 602 603 604 605 606 607 608 609 610 611 612 613 614 615 616 617 618 619 620 621 622 623 624 625 626 627 628 629 630 631 632 633 634 635 636 637 638 639 640 641 642 643 644 645 646 647 648 649 650 651 652 653 654 655 656 657 658 659 660 661 662 663 664 665 666 667 668 669 670 671 672 673 674 675 676 677 678 679 680 681 682 683 684 685 686 687 688 689 690 691 692 693 694 695 696 697 698 699 700 701 702 703 704 705 706 707 708 709 710 711 712 713 714 715 716 717 718 719 720 721 722 723 724 725 726 727 728 729 730 731 732 733 734 735 736 737 738 739 740 741 742 743 744 745 746 747 748 749 750 751 752 753 754 755 756 757 758 759 760 761 762 763 764 765 766 767 768 769 770 771 772 773 774 775 776 777 778 779 780 781 782 783 784 785 786 787 788 789 790 791 792 793 794 795 796 797 798 799 800 801 802 803 804 805 806 807 808 809 810 811 812 813 814 815 816 817 818 819 820 821 822 823 824 825 826 827 828 829 830 831 832 833 834 835 836 837 838 839 840 841 842 843 844 845 846 847 848 849 850 851 852 853 854 855 856 857 858 859 860 861 862 863 864 865 866 867 868 869 870 871 872 873 874 875 876 877 878 879 880 881 882 883 884 885 886 887 888 889 890 891 892 893 894 895 896 897 898 899 900 901 902 903 904 905 906 907 908 909 910 911 912 913 914 915 916 917 918 919 920 921 922 923 924 925 926 927 928 929 930 931 932 933 934 935 936 937 938 939 940 941 942 943 944 945 946 947 948 949 950 951 952 953 954 955 956 957 958 959 960 961 962 963 964 965 966 967 968 969 970 971 972 973 974 975 976 977 978 979 980 981 982 983 984 985 986 987 988 989 990 991 992 993 994 995 996 997 998 999 1000 1001 1002 1003 1004 1005 1006 1007 1008 1009 1010 1011 1012 1013 1014 1015 1016 1017 1018 1019 1020 1021 1022 1023 1024 1025 1026 1027 1028 1029 1030 1031 1032 1033 1034 1035 1036 1037 1038 1039 1040 1

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

A WIDEBAND MULTIBAND INTERNAL ANTENNA DEVICE AND A PORTABLE
RADIO COMMUNICATION DEVICE COMPRISING SUCH AN ANTENNA
DEVICE

5 FIELD OF INVENTION

The present invention relates generally to an internal planar antenna device in radio communication and more particularly to a wideband multiband internal planar antenna for a radio communication device such as a mobile telephone
10 adapted for use with at least two frequency bands.

BACKGROUND

In recent years, mobile telephones have become increasingly popular. At present time, mobile systems in different places in the world utilize different frequency bands for
15 radio communication. Some widely used systems are AMPS (Advanced Mobile Phone Service), GSM 900 (Global System for Mobile communications), DCS 1800 (Digital Cellular System) and PCS 1900 (Personal Communications Services). Several solutions exist where combinations of frequency bands are
20 used in one telephone.

It is often desirable to provide a telephone that operates in a plurality of systems. It is also desirable to provide an antenna that is as small as possible in order to make it possible to provide a very compact telephone.

25 Protruding antennae are frequently used in mobile telephones, however it is difficult to achieve a compact telephone with a protruding antenna. Such an antenna can also be experienced as annoying if it gets entangled in a pocket

for example. Therefore it is desirable with integral antennae, in connection with mobile telephones.

In EP 0892459 it is described how to tune a planar antenna with two resonance frequencies to desirable frequencies.

5 This is achieved by switching between different tuning elements. Thereby it is possible to provide access to four different radio communication systems.

A drawback with this solution is that it is necessary to switch between different tuning elements to tune the antenna to the desired frequency, where the switching requires complex technical solutions and the switching takes time.

Through US 5926139 it is disclosed how to use a planar antenna in two frequency bands. Two radiating portions are connected to a common feeding portion. Together the three portions have an overall configuration shaped generally like the letter J. The antenna operates in the frequency bands 824-896 and 1850-1990 MHz.

15 A drawback with this solution is that the lower frequency band is narrow.

It is generally known that it is difficult to provide a planar antenna for dual band where the lower of the two bands covers both GSM 900 and AMPS operating frequencies.

A further frequency band is the 2.4 GHz band, which is utilized in Bluetooth applications.

OBJECTS OF THE INVENTION

An object of the present invention is to provide an antenna device that operates in at least two frequency bands, where

the lowest frequency band is sufficiently wide without need of different tuning elements.

Another object of the present invention is to provide an antenna device of the kind initially mentioned that is compact and internal in a mobile telephone.

A further object of the present invention is to provide a compact antenna, which is easy and cost effective to produce.

SUMMARY OF THE INVENTION

The invention is based on the realisation that it is possible to provide an internal antenna that operates in a wide lower frequency band and in a higher frequency band.

The above mentioned objects among others are, according to the invention, attained by an antenna device and by a portable radio communication device as claimed in the appended claims.

According to the present invention there is provided an antenna device as defined in claim 1.

There is also provided an antenna device according to the present invention as defined in claim 14.

There is further provided a portable radio communication device according to the present invention as defined in claim 18.

Further advantages are achieved by features defined in the dependent claims.

BRIEF DESCRIPTION OF DRAWINGS

The present invention will become more fully understood from the detailed description of embodiments of the present invention given hereinbelow and the accompanying figures, which are given by way of illustration only, and thus are not limitative of the invention, in which:

Fig. 1 shows an antenna device according to the invention,

Fig. 2 shows an embodiment with an additional antenna for short-range communication, and

Fig. 3 shows an exploded view of a portable radio communication device with an antenna device according to the invention.

DETAILED DESCRIPTION OF THE INVENTION

In the following description, for purposes of explanation and not limitation, specific details are set fourth, such as particular hardware, applications, techniques, etc. in order to provide a thorough understanding of the present invention. However, it will be apparent to one skilled in the art that the present invention may be utilized in other embodiments that depart from these specific details. In other instances, detailed descriptions of well-known methods, protocols, apparatuses, and circuits are omitted so as not to obscure the description of the present invention with unnecessary details.

Reference will now be made to Fig. 1, wherein an antenna device for a mobile telephone is shown, where a planar antenna is utilized to provide wideband multiband frequency coverage.

The antenna device comprises a single planar radiating element 3, having a first and a second portion, which are shaped like two orthogonal generally rectangular elements with a portion in common. This gives the antenna a general shape of the capital letter L. The first portion, generally enclosed by a dotted line 8 and extending vertically in the figure, resonates essentially in a first, lower frequency band, and the second portion, generally enclosed by a dotted line 7 and extending horizontally in the figure, resonates essentially in a second, higher frequency band.

In order to reduce the length of the second portion a slit 5 is provided, where the slit has a first part that is approximately 45 degrees angular to an edge of the second portion and a second part that is essentially parallel to the edge of the second portion. With the slit 5 provided it is possible to achieve a desired resonance frequency with an overall length that is shorter than a quarter of a wavelength, which is convenient to achieve the desired resonance frequency when a grounding element is utilized.

A grounding element is connected, at a point 1, to the radiating element 3 at a corner of the common portion and is connectable to a ground element 4. The ground element 4 is in a plane different from a plane of the radiating element 3. A feeding element is connected, at a point 2, to the radiating element 3 at an edge of the first radiating portion, at a distance d of approximately 15 mm from the grounding element, and is connectable to a transceiver circuit (not shown).

The grounding element could be connected to an edge of the radiating element 3 instead of to a corner. The feeding element would in this case still be connected to the radi-

ating element 3 at an edge of the first portion, at a distance d of approximately 15 mm from the grounding element.

The feeding element could be connected to a notch in the edge of the radiating element 3 in the embodiments described above.

In order to describe an alternative embodiment according to the present invention reference is made to Fig. 2. An antenna device for a mobile telephone is shown, where two (a first and a second) planar antennae are utilized to provide wideband multiband frequency coverage. The first planar antenna has a radiating element 3 with dual band coverage, where a lower frequency band and a middle frequency band are provided. The second planar antenna has a radiating element 6 with single band coverage, where a higher frequency band is provided.

The first planar antenna is as described above. The second planar antenna has a resonance frequency with sufficient bandwidth so that it is possible to utilize in Bluetooth applications. The second planar antenna utilizes the same ground element as the first planar antenna. It can utilize the same transceiver unit as the first planar antenna or a separate transceiver unit whichever is preferred. It is due to the unique shape of the first planar antenna that it is possible to provide the second planar antenna for Bluetooth applications and still get a compact antenna.

The first frequency band mentioned above is about 824-960 MHz (AMPS and GSM 900), said second frequency band is about 1710-1880 MHz (DCS 1800) or 1880-1990 MHz (PCS 1900), and said third frequency band is about 2400-2500 MHz (Bluetooth).

A portable radio communication device will be described with reference to Fig. 3. The portable radio communication device has a housing that encapsulates an antenna 9, wherein the antenna can be any of previously mentioned antenna devices.

Radiating elements described herein is to be interpreted as elements that can both receive and/or transmit radio frequency radiation.

It will be obvious that the invention may be varied in a plurality of ways. Such variations are not to be regarded as a departure from the scope of the invention. All such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the appended claims.

CLAIMS

1. An antenna device for transmitting and/or receiving RF radiation in at least two separate frequency bands, comprising a first and a second frequency band, comprising:

- an essentially planar radiating conductive element (3) comprising a first and a second portion, wherein said first portion radiates essentially in the first frequency band and the second portion radiates essentially in the second frequency band,
- a feeding element connected (2) to said radiating conductive element (3) and connectable to a transceiver circuit, and
- a grounding element connected (1) to said radiating conductive element (3) and connectable to a ground element (4),

characterised in that

- said first and second portions are generally rectangular, essentially orthogonal to each other and have a common portion, whereby a wide first frequency band is provided.

2. The antenna device according to claim 1, wherein the second frequency band is higher than the first frequency band.

3. The antenna device according to any of the preceding claims, wherein the second portion comprises a slit (5).

4. The antenna device according to any of the preceding claims, wherein the first frequency band is about 824-960 MHz.
5. The antenna device according to any of the preceding claims, wherein the grounding element is connected (1) to the radiating conductive element (3) at a corner of said common portion.
6. The antenna device according to any of the preceding claims, wherein the feeding element is connected (2) to the radiating conductive element (3) at an edge of said second portion.
7. The antenna device according to any of claim 1 to 4 or 6, wherein the grounding element is connected to the radiating conductive element (3) at an edge of said radiating element.
8. The antenna device according to any of the preceding claims, wherein the first and second portions together have the general shape of the capital letter L.
9. The antenna device according to any of claims 3 to 8, wherein the slit (5) is open at one end thereof.
10. The antenna device according to any of claims 3 to 9, wherein the slit (5) is partially parallel to an edge of said second portion.
11. The antenna device according to any of claims 3 to 10, wherein a part of the slit (5) is 45 degrees angular to an edge of said second portion.
12. The antenna device according to any of the preceding claims, further comprising:

- a second essentially planar radiating conductive element (6), which radiates in a third frequency band,
- a second feeding element connected to said second essentially planar radiating conductive element and connectable to a transceiver circuit, and
- a second grounding element connected to said second essentially planar radiating conductive element and connectable to said ground element (4)..

13. The antenna device according to claim 12, wherein the second essentially planar radiating conductive element (6) is at least partly located within a frame, which is limited by a general rectangular shape that circumscribes the first essentially planar radiating conductive element (3), but which does not overlap the first essentially planar radiating conductive element (3).

14. An antenna device for transmitting and/or receiving RF radiation in three separate frequency bands, namely a first, a second, and a third frequency band, comprising:

- a first essentially planar radiating conductive element (3) comprising a first and a second portion, wherein said first portion radiates essentially in the first frequency band and the second portion radiates essentially in the second frequency band,
- a first feeding element connected (2) to said first radiating conductive element (3) and connectable to a transceiver circuit,

- a first grounding element connected (1) to said first radiating conductive element (3) and connectable to a ground element (4),

characterised in that

5

- said first and second portions are generally rectangular, essentially orthogonal to each other and have a common portion, whereby a wide first frequency band is provided,
- and wherein the antenna device comprises a second essentially planar radiating conductive element (6), which radiates in the third frequency band,
- a second feeding element connected to said second essentially planar radiating conductive element (6) and connectable to the transceiver circuit, and
- 10 - a second grounding element connected to said second essentially planar radiating conductive element (6) and connectable to said ground element (4).

15. The antenna device according to claim 14, wherein the first frequency band is the lowest frequency band.

20 16. The antenna device according to any of claim 14 or 15, wherein the first frequency band is about 824-960 MHz.

17. The antenna device according to any of claims 14, to 16 wherein the third frequency band is about 2400-2500 MHz.

18. A portable radio communication device comprising:

- 25 - a housing,

- an antenna in the housing,

characterised in that

- the antenna comprises an antenna device according to any
of the preceding claims.

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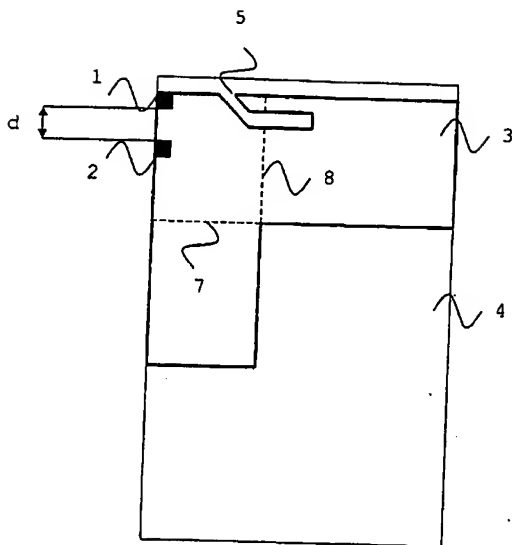


FIG. 1

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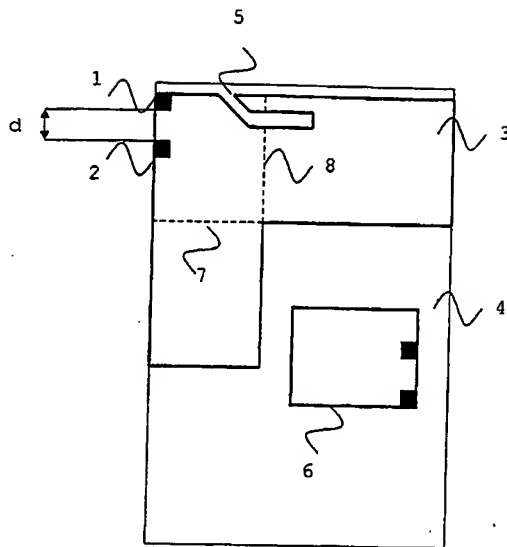


FIG. 2

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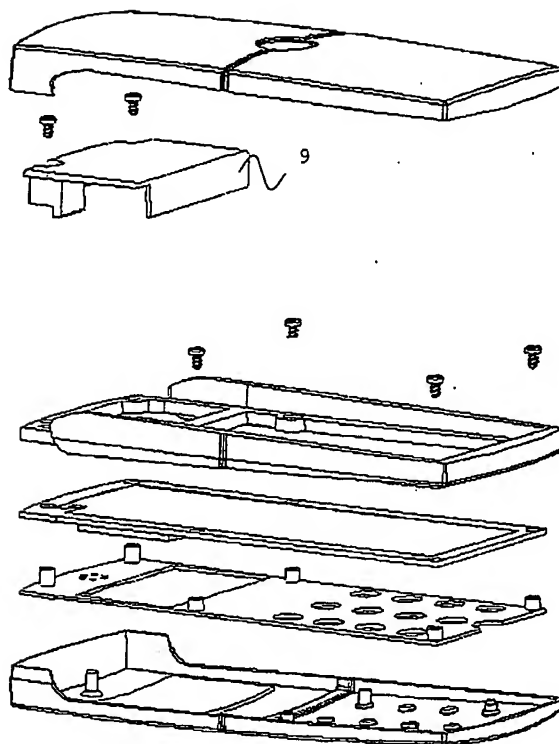


FIG. 3

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 01/00369

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H01Q 1/38, H01Q 5/00, H01Q 1/24

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: H01Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, PAJ

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A	WO 9844588 A1 (QUALCOMM INCORPORATED), 8 October 1998 (08.10.98), page 7, line 1 - line 19; page 8, line 16 - line 28 --	1
A	US 5926139 A (KORISCH), 20 July 1999 (20.07.99), column 3, line 9 - line 19 --	1
A	EP 0942488 A2 (MURATA MANUFACTURING CO. LTD.), 15 Sept 1999 (15.09.99), column 4, line 47 - line 58; column 5, line 21 - line 37 --	1

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

Date of mailing of the international search report

8 June 2001

15-06-2001

Name and mailing address of the ISA/
Swedish Patent Office

Authorized officer

INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 01/00369

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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